IPRO 303 Final Report

Fall 2007

Information Design for Plant Management to Predict Equipment Failure

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0.1 Introduction

Fall 2007 Semester of IPRO 303: Information Design for Plant Management to Predict Equipment Failure, attempts to study the day in a life of individuals involved in decision making process in a Coal Fired Power Plant. This is done in order to better understand the process involved in the management of planned and unplanned maintenance in Power Plants. These set of individuals have already been identified as the shift supervisors, Operations Manager and Engineering Specialists by the previous IPRO group that worked on the first phase of this project of identifying key personnel and decision making in a coal fired power plant.

0.2 Background

Information about Sponsor

Smart Signal© is a privately owned corporation that is located in Lisle IL. Their software which is an asset analytic application offers predictive analysis, diagnosis and prioritization of sensor data from critical equipments in various Power Plants. The uniqueness of these different equipments is also incorporated into the designing of their software application so as to provide early and accurate predictions of failure. Their list of clients spans over 250 Plants in 8 different industries worldwide.

User Problems

Smart Signal's applications operate by installation of sensors in various equipments that are used in different Power Plants. These sensors generate hundreds of alerts daily, thereby making decision making difficult for the people in charge of maintenance in these plants.

Different analyses have been done to reduce the number of alerts generated daily and to properly prioritize the alarms but the number is still not in the range that is easily manageable.

Smart Signal is also working on improving their application in order to ensure the prompt delivery of relevant information to the right people.

Technology and Science Involved

Our approach to solving the problems we were faced with is similar to method employed by the previous IPRO team. It involved the conduction of series of interviews with Shift Supervisors and Engineering Specialists in various Coal-fired Power Plants. Analysis of the data extracted from these interviews was then carried out in order to present the information obtained in a way that will be helpful to our sponsor.

Historical Success or Failures in Addressing the Problems

Smart Signal aligned with OSI soft September 2005 in order to improve their product. OSI soft's product, a real-time performance management based platform, compliments

Smart Signal's product by allowing information gathering, addition of context and visualization of data in order to enhance its predictive capabilities.
Research has been done on ways to enhance the prioritization of alarms received by the end user in a Plant.
During the Spring of 2007, the first phase of the IPRO projected was focused on identifying the "right people" that make maintenance decision in a Power Plant so that our sponsor can know the people that make decision based on the alarms received from their product. These people were identified by the previous IPRO team as the Shift Supervisor, the Engineering Specialist and the Operations Manager.

Ethical, Moral, Cultural Issues

Main ethical and moral issues encountered in conducting research was disclosure of identities of the sponsor to the plant personnel as this would affect their natural answers and give us biased answers. Similarly we did not want to disclose information about the personnel working in plants to our sponsor with their personal opinion. Thus we compiled our report not including any names. However we decided should the interviewed professional ask us if there was a sponsor involved we would disclose that information.
There were no cultural issues involved and our multicultural team comprising of members from various cultural backgrounds successfully worked with collaboration to successfully deliver sponsor desired results.

Business Cost of the Problem

Since Smart Signal application was designed to alert customers of impending failures in their equipments, the inability of their customers to effectively manage information received from various sensors properly may invariably result in the breakdown of the said equipment. These Problems will cost both parties because:

- They make the purpose of purchasing the predictive application from Smart Signal to be defeated due to equipment failures which may persists at the same rate in Plants. This may result in loss of customers for Smart Signal.
- The Plant (i.e. Smart Signals customers) will also experience loss due to outages resulting from these failures.

Implementation of Solution

The information obtained at the end of the Project will be useful to both our sponsor, in better understanding the need of the need of their customers, and the subsequent teams that will be working with Smart Signals in improving their products.
This information will also be useful for subsequent IPRO team in designing a User interface for Smart Signal's application software.

0.3 Purpose

The present IPRO is a continuing research based on the findings of the previous semester during which they concluded that planned maintenances in a coal fired plant are carried out by 'Engineering Specialists' and the 'Operations Manager" whereas unplanned outages are taken care of by the 'Shift Supervisor' .
Our IPRO team focused on helping our Sponsor to better understand the "right people" i.e. end users already identified by the previous IPRO team as the Engineering Specialist, Shift Supervisor and the Operations Manager.

Definition of Objectives
Our objectives for this semester include:

- Conducting a "Day-in-the-Life" study for both the two categories of personnel described above by direct solicitation of information from plant personnel.
- Developing methods to gather this information such as surveys and/or interviews.
- Compilation of the gathered data into a comprehensive report which should benefit the sponsor in better understanding their potential users.

0.4 Research Methodology

The main challenge during the IPRO was gathering the right data needed to find everything about a 'day in the life" of the engineering specialist and shift supervisor. The data also needed to be formatted so as to be convenient for analysis. Therefore first a timeline was decided upon which roughly included the following core objectives in chronological order

a) Elect a team leader and create sub-groups
b) Create a project plan
c) Contact power plants and schedule interviews
d) Compile questions for interviewees
e) Collect data from engineering specialist and shift supervisor
f) Analyze the data
g) Create an IPRO website
h) Prepare a final report, presentation and display
i) Submit all deliverables throughout the project

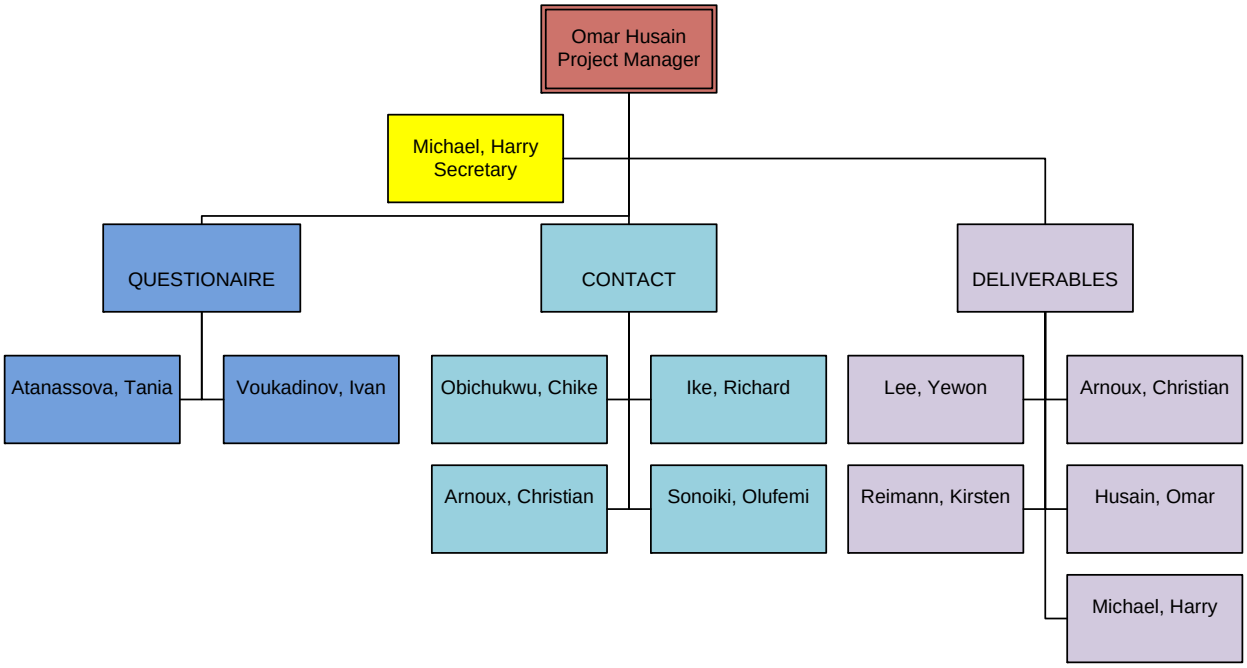
In order to accomplish these tasks, the team was split into three sub-groups. These groups were dynamic in nature, if one group needed help while another was not fully engaged, a team member may switch between groups temporarily to help out. This turned out to be a very effective approach. The three main groups are as follows:

Contact group: This group was responsible for finding and establishing first contact with the power plants, scheduling interviews and making sure that the right people were going to be interviewed.

Questionnaire/Interview Group: This group was responsible for compiling the questions to be asked. The group had to make sure the questions were relatively open-ended so as to allow the interviewee to elaborate on the subject matter. Once interviews started this group is to conduct interviews as well.

Deliverables Group: This group was responsible for submitting all deliverables on time and completed as required.

All three groups were to be involved in the final data analysis with each team member submitting their interviews first formatted in excel files. Harry then took all these files and compiled the final data results. An organizational chart of the team shows how everything is organized:



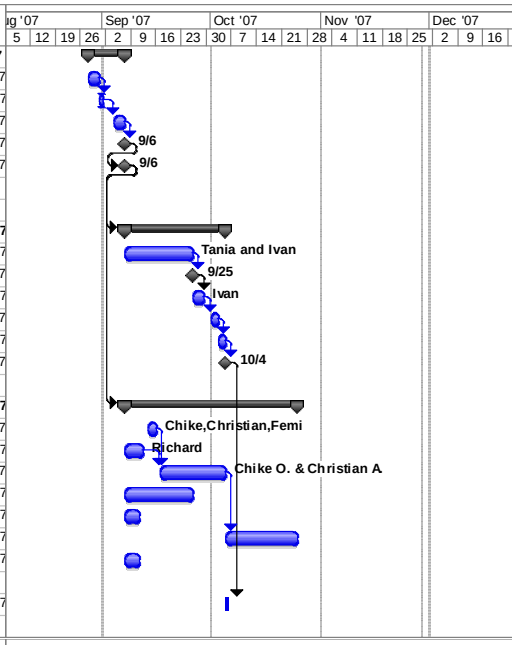
0.5 Assignments

The team comprised of the following members, their contribution are shown along with their skills and subgroup allotment:

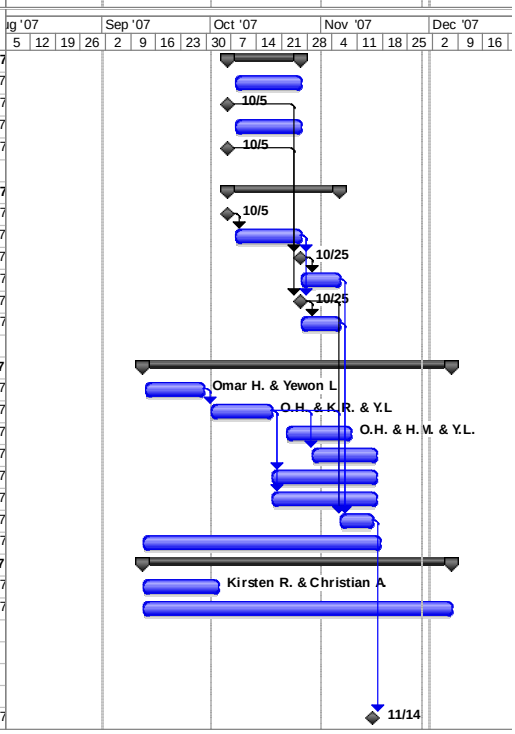
Name	Major / Minor	Skills	Work Experience	Sub-Group	Present contributions towards IPRO project progress
Omar Husain	Mechanical Engineering	- Computer programming (VB, C++, MATLAB). - Autocad. - MS Project and Project management skills. - Website Design	- Intern (product design) successfully completed at UT Houston Summer 2006 and Summer 2007. - Aircraft engineering intern at Air Sahara airlines(now JetLite Airways), India 2005	Project Manager & Deliverables	- Developed Project timeline. - Conduct meetings as project manager. - Maintain schedule for completion of tasks. - Written Project Plan.
Yewon Lee	Computer Science	-Computer Programming (Java,C) - Photoshop/Illustrator - Database (SQL)	Intern (Database Design) at Motorola	Deliverables	Project Plan
Ivan Voukadinov	Mechanical Aerospace	-Autocad -Vectorworks -MS Office	- Best Buy (3yrs)	Questionnaire	Developed and Presented Questionaire
Harshill Parikh	Electrical Engineering	-C, C++, MATLAB -Project Management Skills	- Summer Intern (Schneider Electric0 - Lab Test Intern	Questionnaire	Questions for Engineers
Harry Michael	Mechanical Engineering	-CAD - Communication Skills - Photoshop	- National Honors Society	Deliverables & Project Secretary	-Meeting Agenda & Minutes
Christian Arnoux	Chemical Engineering	-Excel -Engineering Design /w AutoCAD -C++ Programming	Intern (UOP) Summer	Contact & Deliverables	-Ethics Workshop -Contact PowerPlants - Ethics Code
Chike Obichukwu	Electrical Engineering	- Public Speaking - MS Office, C++ -Project Management	Intern (Rockwell Collins Inc)	Contact	-Powerplant research -Contact Powerplants
Richard Ike	Mechanical Engineering	-Autocad, C++, MS Office, MathLAB	Research Asst. Product Personell (IIT)	Contact	-Email draft for contacting Powerplants.
Tania Atanassova	Arch. Engineering	-Autocad, MS Office -Building systems design	Drafter/Designer	Questionnaire	-Develop Questions -Review previous group's work
Kirsten Reimann	Chemical Engineering	-MATLAB, AutoCAD, Excel - Leadership (Kappa Phi Delta and AICHE)	Intern in R&D (UOP) Autocad Intenr (Elara)	Questionnaire & Deliverables	-Ethics Code - Contact old team
Olufemi Sonoiki	Mechanical Engineering	-MATLAB and AutoCAD	Co-op (All Cell Tech. LLC) Quality Assurance Intern (Benthos Pharma, Nigeria)	Contact	-Listing Powerplants

Project Schedule is show in the following attached Project plan Gantt charts

ID	Task Name	Duration	Start
1	**Team Organization**	**8 days?**	**Tue 8/28/07**
2	Defining the Objective	3 days	Tue 8/28/07
3	Deciding on an approach	1 day	Fri 8/31/07
4	Creation of Sub Groups based on tasks	3 days	Tue 9/4/07
5	Allotment of Positions	0 days?	Thu 9/6/07
6	Team Organizaion Complete	0 days	Thu 9/6/07
7			
8			
9	**Questionaire Team Tasks**	**21 days**	**Fri 9/7/07**
10	Compile Questions	14 days	Fri 9/7/07
11	Presentation of Questions for team discussion	0 days	Tue 9/25/07
12	Prioritize and Categorize questions	3 days	Wed 9/26/07
13	Review questions with Psychology professor	2 days	Mon 10/1/07
14	Finalize Interview Questions	2 days	Wed 10/3/07
15	Submit Final Questions questions to Interview group	0 days	Thu 10/4/07
16			
17	**Contact Team Task**	**35 days**	**Fri 9/7/07**
18	Research Potential Companies (Coal Power Plants)	2.67 days	Thu 9/13/07
19	Draft and Review Communication Letter	3 days	Fri 9/7/07
20	Contact 1st Set of Powerplants and set up Interviews	14 days	Mon 9/17/07
21	Schedule Plant tours	14 days	Fri 9/7/07
22	Submit interview schedules to Interviews group	2 days	Fri 9/7/07
23	Contact Second Batch of Powerplants and Set up interviews	14 days	Fri 10/5/07
24	Submit Interview Schedules to Interview groups	2 days	Fri 9/7/07
25			
26		1 day?	Fri 10/5/07
27			



ID	Task Name	Duration	Start
28	**Interview tasks**	**14 days**	**Fri 10/5/07**
29	Go to 1st Batch of interview locations and conduct meeting/Interviews	14 days	Mon 10/8/07
30	Submit Interview Results to Analysis group	0 days	Fri 10/5/07
31	Go to 2nd Batch of interview locations and conduct meeting/Interviews	14 days	Mon 10/8/07
32	Submit 2nd Set Interview Results to Analysis group	0 days	Fri 10/5/07
33			
34	**Analysis tasks**	**21 days**	**Fri 10/5/07**
35	Receive present Questionaire	0 days	Fri 10/5/07
36	Develop Approach to analyze questionaire answers into meaningful reports.	14 days	Mon 10/8/07
37	Receive Completed 1st Batch of Interviews	0 days	Thu 10/25/07
38	Analyze 1st Interviews	7 days	Fri 10/26/07
39	Receive 2nd Batch of Interviews	0 days	Thu 10/25/07
40	Analyze 2nd Batch of Interviews	7 days	Fri 10/26/07
41			
42	**Deliverables**	**63 days?**	**Wed 9/12/07**
43	Project Plan	13 days?	Thu 9/13/07
44	Midterm Report	13 days?	Mon 10/1/07
45	Website	14 days	Mon 10/22/07
46	Abstract	14 days	Mon 10/29/07
47	Final Presentation	21 days	Thu 10/18/07
48	Poster	21 days	Thu 10/18/07
49	Final Report	7 days	Tue 11/6/07
50	Compile Minutes and Submit on 11/16	49 days?	Wed 9/12/07
51	**Ethics**	**63 days?**	**Wed 9/12/07**
52	Develop Code of ethics	16 days	Wed 9/12/07
53	Monitor compliance with code of ethics in class	63 days?	Wed 9/12/07
54			
55			
56			
57			
58	***Estimated Completion of Project***	0 days	Wed 11/14/07



0.6 Obstacles

Several significant obstacles were encountered as the project progressed. Firstly, none of the team members had any previous experience with this type of research. It was initially unknown what exactly was expected from the team. This led to confusion about the team structure. The team decided as a group to divide in three groups with a dynamic structure, so that members of each team can fluctuate between groups if needed. Thus a contact group, questionnaire group and deliverables groups were formed. Once interviews started, the dynamic structure took over and member of the contact and questionnaire groups conducted interviews and helped with deliverables. The questionnaire group encountered difficulty in composing questions that would find out the most information from the interviewees. Several group presentations for discussion of the questions were required for them to be satisfactory.

Ethics was another obstacle encountered. The team initially wanted to record the phone interviews and even the live ones, however that might lead to biased answers. It was decided that it would be unethical to record the interviews without the interviewee's consent. Notes were taken instead. This led to the issue of whether or not the sponsor's should be disclosed to the interviewees, and also if the interviewees should know the team had a sponsor at all. A group vote was taken, and it was decided that it would not be revealed to interviewees that we are sponsored. If asked specifically about it, we would have answered yes without disclosing the name.

Once ethics and group structure were decided upon, the biggest obstacle was getting in contact with as many power plants as possible, and more importantly, getting an interview from them. Many plants did not reply or refused to participate. The contact team had to start from scratch, but worked hard and got a satisfactory number of interviews coming in on a steady basis for us to work on. After the interview process started, the process smoothed out and no major obstacles were encountered. The dedication and hard work to overcome the mentioned obstacles were key factors in the success of the IPRO. If in the future research is still being conducted in a similar manner, our system is a pretty effective way to do it. However, other obstacles may rise up if Smart Signal decides to sponsor a future IPRO to develop or improve existing software. Our team would be incapable of dealing with this kind of work, and some students with knowledge in computer science would be needed.

0.7 Results

The answers acquired from the interviews conducted both for Shift supervisors and Engineering specialist yielded answers on various aspects of the work life of these two individuals, these answers are shown for all conducted interviews in Appendix III.
The answers were then quantified into various points and the frequency of these points, the recurrence of a common answer would help us determine the majority opinion. An example question is shown below:

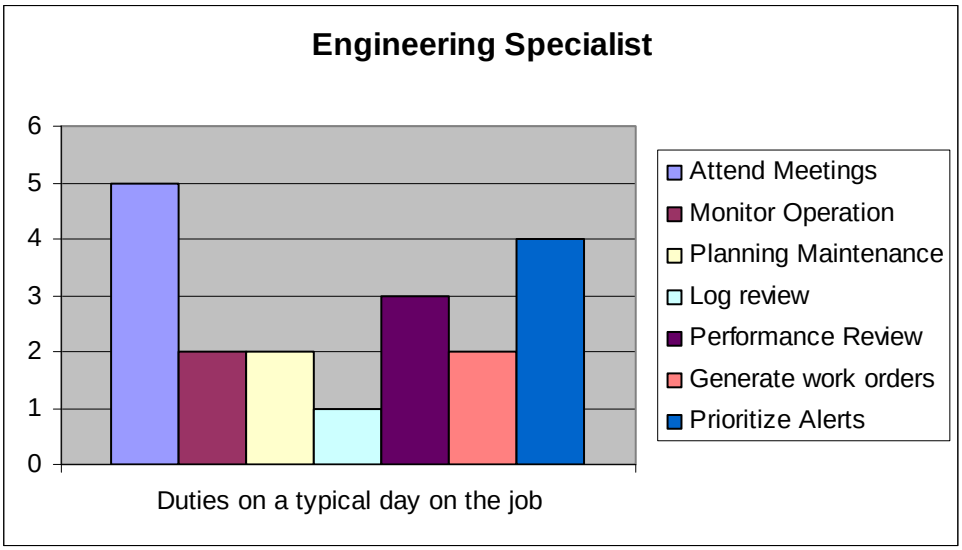
Question: What are your duties on a typical day on the job?

Answer: Large part of my job is to manage the **capital budget**; second largest would be to make sure that everything in the plant is **operating smoothly**. I attend morning & evening **meetings** in which I get report about any problems, my job is to **prioritize** and identify if the **problem is reoccurring**.

Analyzing this answer required us to mark out key points in this particular answer as well as all the other answers for all interviews which for this particular example gives us the following points:

- Capital Budget
- Ensure Smooth Operation
- Attending Meetings
- Problem Reoccurrences Identification
- Error Prioritization.

as the job responsibilities for the person interviewed. After adding up all the answers from all interviews, we are able to represent the results as shown in the following chart:



The results for all the answers are demonstrated in Appendix IV.

Conclusions from Results:

After a review of the overall answers, we are able to summarize short descriptions of the individuals as shown below:

Engineering specialists:

- Their main daily tasks were attending meeting and Prioritizing Maintenance alerts.
- They are largely responsible for Generating work orders, meeting with contractors, and scheduling planned maintenance tasks.
- They commonly agree that the toughest part of maintenance is problem identification.
- They plan maintenance based on computer log information and a pre planned outage schedule.
- They also are responsible for startup after an outage.

Shift Supervisors:

- Their main duty is to monitor plant operation during their 8 hour shifts maintaining a log of the events and periodically monitor the control room.
- They are not involved in failure detection but may take an action during off hours to avoid a safety hazard.
- They believe that the main problems faced with unplanned outages are production loss and detection of where the failure occurred.
- They commonly agree that the best method to detect equipment failure is early detection.

Benefits for the sponsor:

We strongly feel that after reviewing our analysis, the sponsor will be able have a better understanding of the potential users of their software product and may use some of this information to shape a new interface for their plant monitoring software package.

Social Benefits:

We hope that a better software would help better control outages thus helping in some way to reduce cost of electricity while helping minimize any safety hazards in a power plant environment. A better more effective software environment will help power plant staff manage emissions and easily notice any increase in emissions thus safeguarding our environment from pollution.

For future IPRO groups:

Future IPRO groups will be able to focus more on optimizing the software interface as we as well as the IPRO before us have gathered adequate information for them to understand a plant environment, communication and potential users and their concerns.
We hope our efforts are able to minimize any research they need to do for software improvement.

0.8 Recommendations

The future IPRO should possibly conduct the following activities to help achieve Smart Signal's goal.

- Focus on the unit operator and engineering specialist. The shift supervisor seemed like he didn't have that much to do relating to plant maintenance.
- Find out as much as possible about the software and methods that they currently use:
    a) What flaws exist in the current software
    b) Which data the unit operator and engineering specialist need most
    c) Whether or not the data they receive is properly prioritized
    d) How can planned maintenance be facilitated from the existing method

These issues can uncover a broad range of new useful information, which will be invaluable to the sponsor.

Acknowledgements

Upon successful achievement of our goals, the team would like to thank our faculty advisors for their guidance especially during times we encountered issues and could not figure out right paths to choose. We are very grateful to the plant managers, engineering specialists, shift supervisors and other staff of all power plant who were able to devote time out of their busy schedules to educate us about power plants and were able to answers our questions. We would have been honored to mention their names here, however we are required to conceal this information.

APPENDIX I : Team designed Questionnaire (Interview)

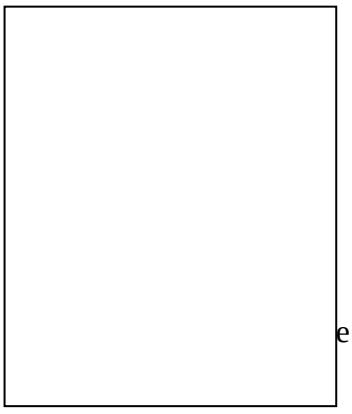
IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____ Date : ___/___/2007

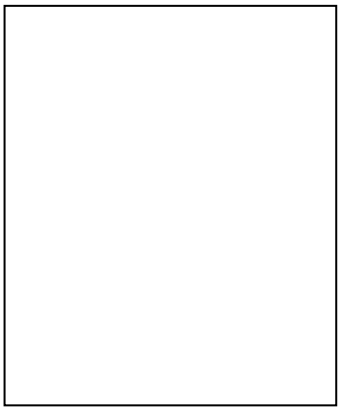
Note: Please leave box on right empty.

For : Engineering Specialist

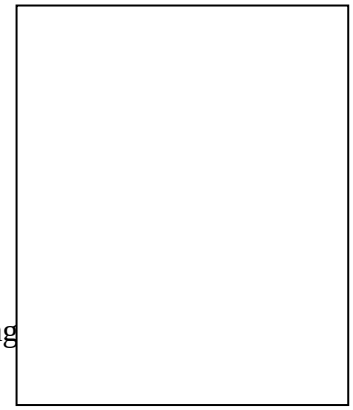
1) What are your duties on a typical day on the job?



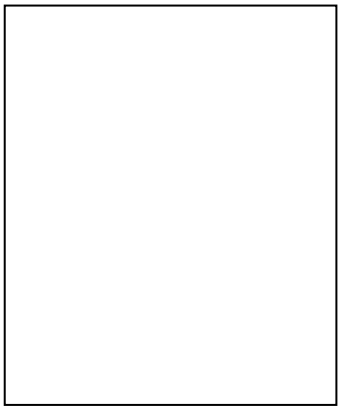
2) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?



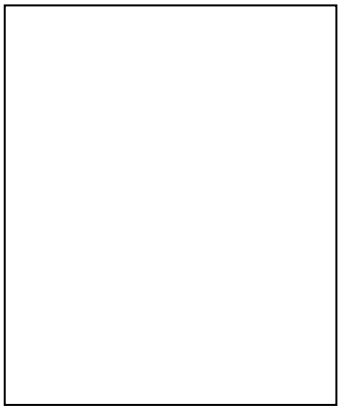
3) What are the most difficult/cumbersome tasks related to planned maintenance? Why?



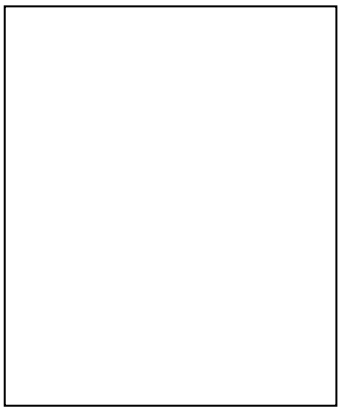
4) How are failures prioritized and sorted? How do you manag
coming in on a daily basis?



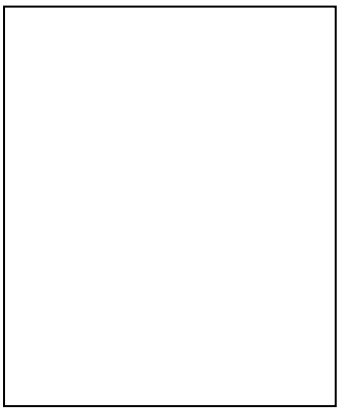
5) What methods are used to plan planned maintenance?



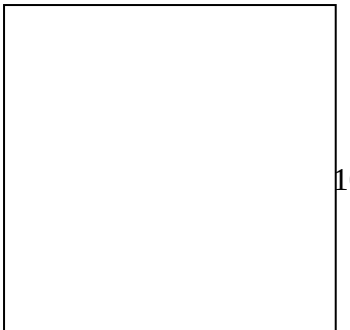
6) What kind of improvement would you like to see on the current method of planning and predicting maintenance?



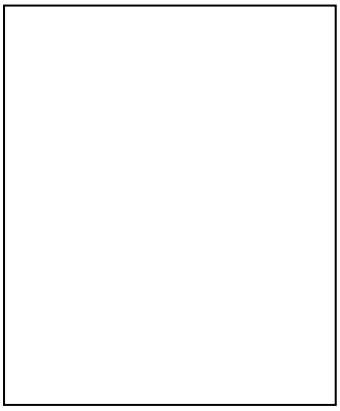
7) What % of maintenance is planned vs. unplanned?



8) How long does planned maintenance last?



9) What steps are taken after a planned maintenance?



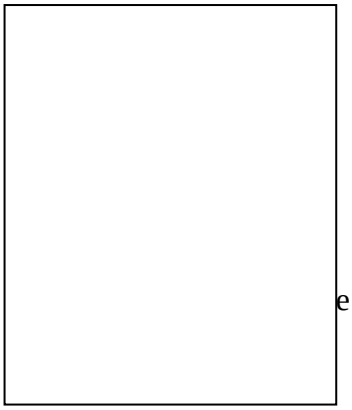
IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____ Date : ___/___/2007

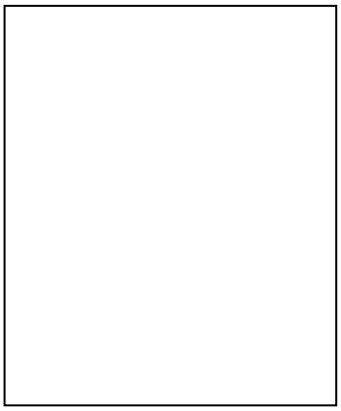
Note: Please leave box on right empty.

For: Shift Supervisor

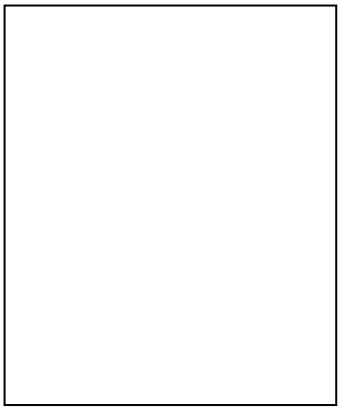
1) What are your duties on a typical day on the job?



2) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

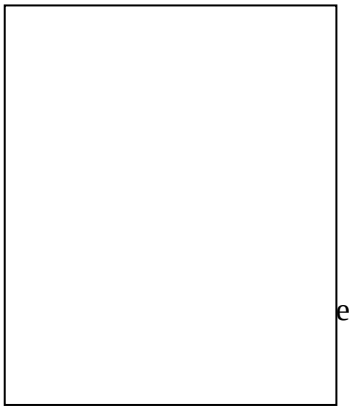


3) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

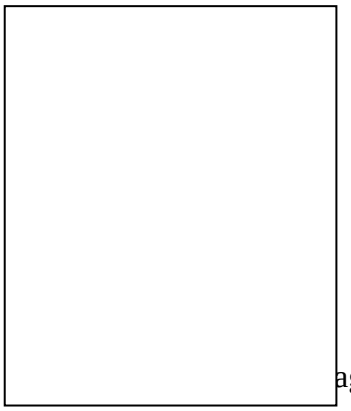


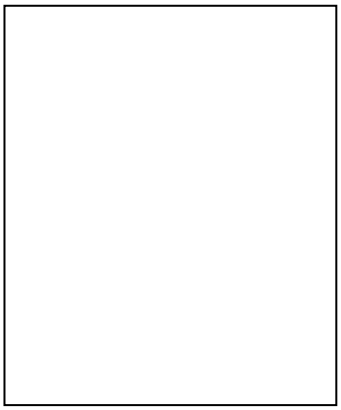
4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

5) What steps do you take when dealing with unplanned maintenance?



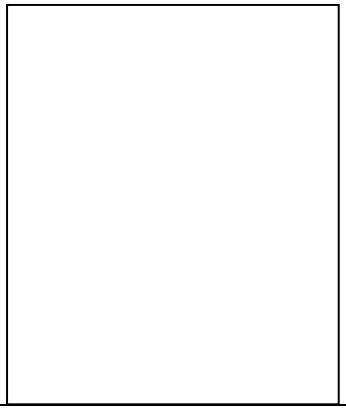
6) How does unplanned maintenance or a power outage affect the operation of the plant?

7)  age, are steps taken to prevent it from happening again?



8) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

9) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?



APPENDIX II : Contact Team's Draft Letters to PowerPlants

Dear Sir/Madam

My name is _____. I am a third year Mechanical Engineering student at Illinois Institute Technology, Chicago. This semester, I am a member of a research project group and our objective is to study the duties of the Engineering specialist and the shift supervisor of coal-fired power plants like yours.

The purpose of this research is to study the "day in the life" of the mentioned engineers and analyze how their decision making process applies to the task of equipment maintenance and prediction of equipment failure. We will like to know what the life-cycle of a maintenance event is and what tools are used to track this maintenance life-cycle, how potential issues are identified, how issues are flagged for further investigation, and how maintenance is prioritized against other maintenance needs.

It would be of great benefit to us if we can visit your plant to carry out brief interviews with these engineers and, if possible, have a guided tour around your facility.

Thank you very much.

_____

APPENDIX III : Conducted Interviews

ENGINEERING SPECIALIST

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials: Tania Date : 10/19/2007

Note: Please leave box on right empty.

For : Engineering Specialist

10) What are your duties on a typical day on the job?

- Scope -
- Budget - 8
- Schedule maintenance - 10
- Review projects - 6

- Hire engineers - 0
- Manage engineering specialists - 0
- Root cause analysis - 10

11) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?

- Schedule planned maintenance
- 2hrs a day

12) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

13) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- Print tickets
- Divide tickets in 4 categories
- Plan maintenance accordingly
- Repeat everyday

14) What methods are used to plan planned maintenance?

- Spread sheet
- 10 years in advance

15) What kind of improvement would you like to see on the current method of planning and predicting maintenance?

- Software – prints tickets based on usage not time

16) What % of maintenance is planned vs. unplanned?

- 70% planned

17) How long does planned maintenance last?

- Short
- Medium
- Long

18) What steps are taken after a planned maintenance?

- Testing
- Start up process
- Train workers
- Order spare parts

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:____O .S__(Crawford Plant MWGP)___Date : ___/___/2007

Note: Please leave box on right empty.

For : Engineering Specialist

19) What are your duties on a typical day on the job?

- *Assisting Plant Operations and ensuring smooth running of Plant*
- *Keep track of failures and make decisions(i.e planned maintenance) based on this data.*
- *Analysis of every failure (equipment) regardless of its cost of effect is.*
- *Handles long term projects such as maintenance*

- *20% helping out day to day*
- *20% helping out maintenance*
- *--% Planned maintenance*

20) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?

- *Fully involved in maintenance , plan in advance of over 5 to 10 yrs*
- *Involved daily in maintenance issues*
- *Also handle or help in solving unplanned maintenance when they occur.*

Fully Involved

21) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

-

22) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- *Safety*
- *Environmental Consequence*
- *Megawatt ratio (Subjection to Specialist's / Plant Manager's decision in terms of importance)*

- *Alarms have priority levels*
- *Priority levels may change due to new laws and codes*

- *Safety*
- *Environmental Consequence*
- *Megawatt Ratio*

23) What methods are used to plan planned maintenance?

- *Failure Analysis*
- *Based on degree of information(e.g failure Alerts or maintenance history) specialist may decide upon a planned maintenance.*

- *Failure Analysis*
- *History of equipment failure.*

24) What kind of improvement would you like to see on the current method of planning and predicting maintenance?

25) What % of maintenance is planned vs. unplanned?

- *2-6% = unplanned*
- *Planned*
    - *56 days – Year 1*

- *10 days – Year 2*
- *28 days – Year 3*
- *10 days – Year 4*
- *28 days – Year 5*
- *10 days – Year 6*
- *28 days – Year 7*
- *56 days – Year 8*

26) How long does planned maintenance last?

It may vary based on the amount of people available. Planned maintenance is usually faster than unplanned Maintenance because there are more resources available during planned maintenance.

Usually faster relative to time taken for unplanned maintenance.

27) What steps are taken after a planned maintenance?

- *Make a schedule of all functions necessary after.*

IPRO 303: Interview

Interviewer's name(s): Harry, Femi, Omar

Engineering Supervisor: Tim Wright

28) What are your duties on a typical day on the job?

Large part of my job is to manage the capital budget; second largest would be to make sure that everything in the plant is operating smoothly. I attend morning evening meetings in which I get report about any problems, my job is to prioritize and identify if the problem is reoccurring.

29) How you are directly involved in planned maintenance? How much of your time is devoted to planning it?

I am not directly involved with detecting a problem; I rely on my staff to keep me updated. An intern comes in every month does test and makes sure that everything seems ok and if there are any problems he reports them to me. I also rely heavily on my working like supervisors to update me on any problems because I cant be everywhere at all times.

30) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

Balancing the Capital budget because there are a lot of factors that play into it.

31) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

a) safety
b) reliability
c) Cost of production.

i am not the only one who manages all the data, mainly people working on the equipment manage the data and if an problem occur, we have meetings in which those problems are addressed. This forces decisions to be made by the people closest to the equipment.

32) What steps do you take when dealing with unplanned maintenance?

We usually have 30% unplanned and 70% planned maintenance. During and outage engineers investigate how can be reduce unplanned outages to increase productivity.

This helps us balance time, man power and money.

33) How does unplanned maintenance or a power outage affect the operation of a plant?

An unplanned outage has a lot of affect on the production of the plant. We look at the lost of output (MW) year by year. After that we look at where the money was spent and if the problem was solved. We also look at how much money we spend on different problems.

34) What % of maintenance is planned vs. unplanned?

We usually have 30% unplanned and 70% planned maintenance.

35) How long does planned maintenance last?

A unit my come off fully 3 to 8 times a year. We are trying our best to decrease this number because we need to compete with the rest of the industry. Less times your unit comes off more out put you have.

36) What steps are taken after a planned maintenance?

We analyze how much output (MW) did we lose. We also look at if we found any more problems within the unit other than the problem we went in looking for because a lot of time if something is going bad in a unit there is a high possibility that their are most problems in the unit that we initially know about.

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials: Christian Arnoux (Joliet) Date : ___/___/2007

Note: Please leave box on right empty.

For : Engineering Specialist

1) What are your duties on a typical day on the job?

-Planner: Planning normal work, every morning look at tickets

-Manager- Eliminates any barriers specialists might run into.

Improvement projects

Reviews of Specialists

Root-Cause analysis

Managing people issues-requesting new engineers

Performance Reviews

½ time on safety

2) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?

-Evaluate existing conditions

See what we initially have to do

Some procedural might go to operations

Change procedure

Write project recommendations

Meet with contractors

Installation

Put together training procedure

Steps of Project:

-Testing procedure

-Train operators

What type of spare parts just in case something fails.

3) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

#1 Safety

#2 Environmental

#3 Megawatts

Controls make a lot of decisions for them

Planner reviews tickets every morning and prioritzes.

95% of time don't touch operating parameters

-can happen if there is an economic reason

-Managers make economic decisions

5) What methods are used to plan planned maintenance?

Long process, specialists in and out.

Usually in spring

A lot of time is in capital projects

-putting in new system

-maintaining system

6) What kind of improvement would you like to see on the current method of planning and predicting maintenance?

SAP a process used to plan needs improvement.

SAP enters PM tickets

7) What % of maintenance is planned vs. unplanned?

More Planned outages, 70% planned ultimate goal.

8) How long does planned maintenance last?

10 year planned, plan a lot of work in 56 day outages

Shorter outages, Spring 10-14 day (Cleaning furnaces)

Tube Leaks: 8 shifts are needed to fix.

Boiler problems: Bigger outages

9) What steps are taken after a planned maintenance?

Clock resets after a planned maintenance

Last 2 weeks- equipment tunnel back to running

Startup

Test runs/pump runs

Interlocks

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____CHIKE OBICHUKWU_____ Date : 10 / 10/ 2007

Note: Please leave box on right empty.

For : Engineering Specialist – CRAWFORD PLANT

1) What are your duties on a typical day on the job?

- Conduct meetings to ensure the plant is running effectively.

2) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?

- Planned maintenance is typically done over a while/ period of time. The different parts of the system are replaced/maintained one at a time, until the whole plant is maintained. This couple be over a couple of years.

(e.g. A boiler has a 2yr maintenance cycle; i.e. you only have to fix it and clean it out every 2years).

3) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

- One of the most difficult (amongst a lot of others) is keeping track of "accurate information" and "interpreting the information correctly". There are a lot of engineers in the plant and in-as-much as they all roughly have about the same "sense of analyzing the situation at hand" equally, there are times when something written down can be interpreted/taken as "more urgent" than it actually is.

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- If it is defying safety and damaging the environment it is given highest priority

- If they're losing money (Megawatts), its also usually given some high priority.

5) What methods are used to plan planned maintenance?

Priority is given based on Safety 1st, Environment 2nd, and then Production 3rd preference (as mentioned above in # 4).

6) What kind of improvement would you like to see on the current method of planning and predicting maintenance?

- Basically, the NSFA codes are what sort of determine if planned maintenance needs to be done at some point even though the plant may be running fine.

These NSFA codes/standards have to be met at every point in time,

so if there are changes in the codes or additions to the codes, an addition may need to be done on the assembly line, or even an overhaul, depends on what the new codes require.

- The current system however works fine, and meets the NSFA regulations.

7) What % of maintenance is planned vs. unplanned?

It depends on the "Forced outage rate". So, Unplanned maintenance is typically 5 – 7% time based.

The plant is working to reduce the number however, and that can be seen in the idea of the engineering turning an "unplanned/forced outage" maintenance in to a planned maintenance, to take advantage of this period to also fix other equipments in the fault assembly line.

8) How long does planned maintenance last?

- Planned maintenance is a continuous process. Different parts of the system are serviced at different times of the year. This cycle is done based on a "# of days per year maintenance cycle", and rotated over 4years.

Described below is this cycle:

56days – in the 1st Year

10days – 2nd year

28 days – 3rd year

10days – 4th year.

- The 56days cycle is done only ONCE every 8years. Among the other years in this 8year period, the maintenance is alternated between 10days and 28days.

9) What steps are taken after a planned maintenance?

Before:

*- 1st a *.mpp file (Microsoft project) with a schedule of the planned outage (This is done before the specific plant line is shutdown/taken out of service)*

- The plant value/parameters are also noted to re-enter them at restart of plant.

After:

- After maintenance, "Commission Testing is done (e.g. re-pressurizing, checking for leaks in the new setup, standardizing the parameters of the parts, etc)

- The plant is re-started and put up to speed.

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____CHIKE OBICHUKWU_____ Date : 10 / 19/ 2007

Note: Please leave box on right empty.

For : Engineering Specialist – JOLIET PLANT

1) What are your duties on a typical day on the job?

- [NOT ANSWERED!]

2) How are you directly involved in planned maintenance? How much of your time is devoted to planning it?

- [NOT ANSWERED!]

3) What are the most difficult/cumbersome tasks related to planned maintenance? Why?

- Giving priority to equipments that need to be fixed.

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- The Control Room does most of the sorting and prioritizing.

- The S.A.P software (a new software which the plant is currently incorporating) manages all the date and reports that come-in daily. It uses this information to help with predicting when maintenance is to be done. And it also helps with generating the actual "maintenance tickets" when a maintenance is due.

5) What methods are used to plan planned maintenance?

The S.A.P Software (a new software) helps with planning for a "planned/unforced maintenance". The software works by monitoring the functionality of the plant parts/sections while they are running. It does this through the Control System. (So, basically, the Control Room System is connected to this software, and the software works on this means, by retrieving the needed data from the control room).

6) What kind of improvement would you like to see on the current method of planning and predicting maintenance?

- The plant is already making the improvement needed. They are moving from "ELLIPSE" to "S.A.P Software".

- Previously, their maintenance cycle was just based on time (so basing the plant part on the number of years they have been working), but now with the new system, its not only based on the number of years, but more details are given to the actual functionality. (e.g. The SAP monitors the plant, by checking for .e.g. how many times a "pressure valve" or "coal inlet valve opens. After a certain number of times, of opening and closing, it states the part is due for repair.)

7) What % of maintenance is planned vs. unplanned?

Planned – 75%

Unplanned – 25%

- They are however working to lower the unplanned/forced percentage drastically.

8) How long does planned maintenance last?

- Done over a number of years. They currently use a "10year plan", and alternate as needed. Below is the plan:

10 days – 15days – these are tune-ups, and are done in summers

24days

56days.

9) What steps are taken after a planned maintenance?

- Over the last 2 weeks of maintenance, "Test Runs" are done on the various parts/section of the particular line assembly.

- After Test Runs, "Tune-Ups" are done to put in the standard/default parameters of how the parts are meant to function.

- After these, the clock is reset (to presume it is running from the beginning, and thus also be monitored based on its clock cycle.

- Finally, the system is tested as a whole for the first time; if nothing goes wrong, the normal functioning continues.

SHIFT SUPERVISORS:

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____CHIKE OBICHUKWU_____ Date : 10 / 19 /2007

Note: Please leave box on right empty.

For: Shift Supervisor – JOLIET PLANT.

1) What are your duties on a typical day on the job?

- The Shift supervisor runs the plant and makes the "moment to moment" decision at different points in time in the day.

- For the Control Room Operator, 1stly, he/she has a face-to-face verbal conversation with the person on the previous shift to get the "up-to-date" status of things.

Next, the log-book is checked to very accuracy of all reports as has been reported in the verbal dialogue.

Then the normal routine of monitoring the plant on the Control Room Screen starts off.

2) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

The Control room/control system does most of the monitoring and detection and give s out signals. The Control Room Operate however verifies that the problems being reported are what's actually happening.

3) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

- Trying to "juggle" or determine the priority of the failures to know which one "really" needs to be fixed first.

- Also, trying to determine where to get resources and equipments from to fix the problems – especially in a case of "unplanned/forced failure"

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- Safety is always number 1. Also, "how severe the problem is, in terms of how much damage it can cause to the equipment is another factor.

- Control in the control system has already been setup to handle (or shutdown) machines that are "running out of parameters/order" and can cause a safety hazard. (These parameters are set by Specialists based on the standards, and their experience).

- All information is recorded and retained daily in the Baily Computers in a room below the Control Room.

-

5) What steps do you take when dealing with unplanned maintenance?

In most cases, they try to avoid the unplanned maintenance by shutting down the plant section far-in advance when they start receiving little sign of an issue.

6) How does unplanned maintenance or a power outage affect the operation of the plant?

- [NOT ANSWERED!]

7) After an unplanned outage, are steps taken to prevent it from happening again?

- Root Cause Analysis (RCA) is done on the failed part/equipment.

- Also, a "lessons learned" session is done (where all the people who participated in the maintenance meet and discuss the lessons), to know:

i) what they can do better next time

ii)how to improve their interpersonal communication skills to avoid mis-communication (which can also be the causes of failure).

8) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

- Basically, a more "trustworthy or reliable system". The current computer system works based on the "parameters" it is fed, and sometimes, unique scenarios that have not been encountered before may come-up, and because parameters don't exist for this scenario, the computer classifies it under something else that already exist – which is wrong.

- Based on this, a conclusion was made by the Controller, that having the old system, whereby people do most of the work is better, because the people work off of their experience, and it takes experience to solve the problem.

9) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

- Typically, unplanned maintenance turns into a Planned Ones. So even though a forced outage happens, and they are forced to thus fix it as soon as possible, they use that opportunity to also service other equipment.

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____CHIKE OBICHUKWU_____ Date : 10 / 19 /2007

Note: Please leave box on right empty.

For: Shift Supervisor – JOLIET PLANT.

1) What are your duties on a typical day on the job?

- The Shift supervisor runs the plant and makes the "moment to moment" decision at different points in time in the day.

- For the Control Room Operator, 1stly, he/she has a face-to-face verbal conversation with the person on the previous shift to get the "up-to-date" status of things.

Next, the log-book is checked to very accuracy of all reports as has been reported in the verbal dialogue.

Then the normal routine of monitoring the plant on the Control Room Screen starts off.

2) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

The Control room/control system does most of the monitoring and

detection and give s out signals. The Control Room Operate however verifies that the problems being reported are what's actually happening.

3) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

- Trying to "juggle" or determine the priority of the failures to know which one "really" needs to be fixed first.
- Also, trying to determine where to get resources and equipments from to fix the problems – especially in a case of "unplanned/forced failure"

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- Safety is always number 1. Also, "how severe the problem is, in terms of how much damage it can cause to the equipment is another factor.
- Control in the control system has already been setup to handle (or shutdown) machines that are "running out of parameters/order" and can cause a safety hazard. (These parameters are set by Specialists based on the standards, and their experience).
- All information is recorded and retained daily in the Baily Computers in a room below the Control Room.
-

5) What steps do you take when dealing with unplanned maintenance?

In most cases, they try to avoid the unplanned maintenance by shutting down the plant section far-in advance when they start receiving little sign of an issue.

6) How does unplanned maintenance or a power outage affect the operation of the plant?

- [NOT ANSWERED!]

7) After an unplanned outage, are steps taken to prevent it from happening again?

- Root Cause Analysis (RCA) is done on the failed part/equipment.

- Also, a "lessons learned" session is done (where all the people who participated in the maintenance meet and discuss the lessons), to know:

i) what they can do better next time

ii)how to improve their interpersonal communication skills to avoid mis-communication (which can also be the causes of failure).

8) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

- Basically, a more "trustworthy or reliable system". The current computer system works based on the "parameters" it is fed, and sometimes, unique scenarios that have not been encountered before may come-up, and because parameters don't exist for this scenario, the computer classifies it under something else that already exist – which is wrong.

- Based on this, a conclusion was made by the Controller, that having the old system, whereby people do most of the work is better, because the people work off of their experience, and it takes experience to solve the problem.

9) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

- Typically, unplanned maintenance turns into a Planned Ones. So even though a forced outage happens, and they are forced to thus fix it as soon as possible, they use that opportunity to also service other equipment.

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____ Date : ___/___/2007

Note: Please leave box on right empty.

For: Shift Supervisor

1) What are your duties on a typical day on the job?

In charge of plant

What decisions to make

Moment to moment decisions

Gets report from unit operator

Planner: Got a problem determines what needs to be done. Go

to people, have paperwork, build work packages turn over to supervisors

2) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

3) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

Operations: Domino Effects, each problem causing another problem

Shift Supervisor: Juggling priorities of jobs.

-determining why a failure happens

-Dealing with emergencies

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

Megawatts and Safety

Equipment protections

5) What steps do you take when dealing with unplanned maintenance?

Shut it down, try to avoid catastrophic failure

Megawatt related, maybe let it run to shut down

6) How does unplanned maintenance or a power outage affect the operation of the plant?

Operations: Can make decisions to shut off equipment

-Call above to make a more difficult decision

7) After an unplanned outage, are steps taken to prevent it from happening again?

Organize planned maintenance schedules

Lessons Learned

Sit down and have root cause analysis

Meet with people to prevent from happening again

8) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

n/a

9) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

N/A

IPRO 303: Interviews (Version 1.0) Interview 4 (Juliet)

Interviewer's Initials: Tania Date : 10/19/2007

Note: Please leave box on right empty.

For: Shift Supervisor

1.What are your duties on a typical day on the job?

- Relief – talk to previous shift
- Check log
- Watch alarms

2. We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

3. What is the most difficult/cumbersome part about dealing with equipment failure? Why?

- Major failure
- Chain reaction in failure

4. How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- Knowledge of equipment
- Experience
- Look at alarms

5.What steps do you take when dealing with unplanned maintenance?

- shut down machine – to avoid catastrophic failure
- what is alarm
- look up info
- act on it

6.How does unplanned maintenance or a power outage affect the operation of the plant?

7. After an unplanned outage, are steps taken to prevent it from happening again?

8.What kind of improvements would you like to see in the current method for predicting and dealing with failures?

- No computers – bad for quick response because they freeze up

9.How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:_____O.S (MDGP Crawford)_____ Date : ___/___/2007

Note: Please leave box on right empty.

For: Shift Supervisor

10) What are your duties on a typical day on the job?

- *First point of contact for most problems*
- *Coordinates the daily activities in the plant and* pass *over All information acquired during shift to the next supervisor.*
- *In charge of plant when director is not around.*

- *First point of contact*
- *Coordinates daily activity in plant.*

11) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

- *Doesn't detect failures*
- *Gets informed by the Unit Operator and other sections of problems if necessary and takes action or logs them.*

Doesn't detect failures

12) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

- *Available resources for unplanned failures or maintenance. i.e availability of specialist (engineering) and even the number of them available at such a time is important.*

13) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

- *Unit Operators looking at the screen has a level of power In making decisions on the importance of a failure alert.*
- *Mainly megawatts and dollar amount,*

- *Unit operator has a considerable power in the deciding how important a failure alert is.*

14) What steps do you take when dealing with unplanned maintenance?

- *Gets the right people to fix the problem and if required, Calls outside help (e.g contract engineering specialist) to fix it.*
- *Operations manager pulls every one(i.e engineering s specialists together when problem or failure alert goes beyond one field of specialization*

15) How does unplanned maintenance or a power outage affect the operation of the plant?

16) After an unplanned outage, are steps taken to prevent it from happening again?

17) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

18) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

It varies depending on the availability of people and resources.

19) What are your duties on a typical day on the job?

IPRO 303: Interviews (Version 1.0)

Interviewer's Initials:Christian Arnoux (Will County)_____ Date : ___/___/2007

Note: Please leave box on right empty.

For: Shift Supervisor

1) What are your duties on a typical day on the job?

-Maintence Supervisors: Work of work orders

-Operations: Responsible for operating plant directs other departments like operating people.

2) We realize you have many things to accomplish on a given day, what methods to you use to detect failure?

-Radios

-Check Sheets

-Unit Capabilities

-Equipment Issues (Prioritzing Work Requests)

-Computer Control Systems

Operations people use less technology depend on experience.

4 yr progression to become fully operation qualified and another 2 years to be fully qualified.

3) What is the most difficult/cumbersome part about dealing with equipment failure? Why?

-What is the equipment? What is the effect it will have on the plant?

-Gathering preliminary information.

-Short Term corrections

Unit Operators: Trends, looking at status.

4) How are failures prioritized and sorted? How do you manage all the data and reports coming in on a daily basis?

5) What steps do you take when dealing with unplanned maintenance?

-"Do this Do it now"

Shift Supervisor contacts maintenance supervisor

"Lock out Tag out", maintenance supplies parts

Specialist only get involved when there is a major problem or chronic problem.

Maintenance Supervisor lines up people.

6) How does unplanned maintenance or a power outage affect the operation of the plant?

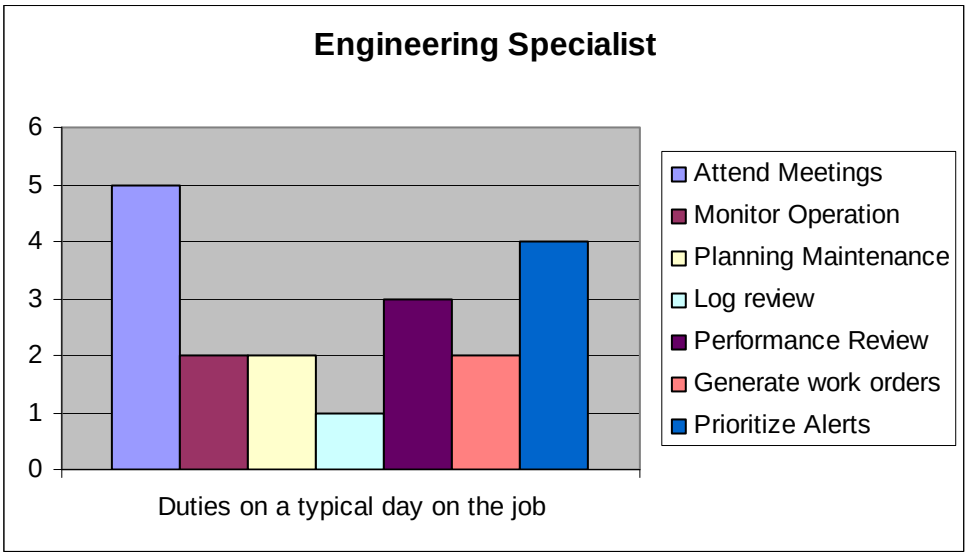
7) After an unplanned outage, are steps taken to prevent it from happening again?

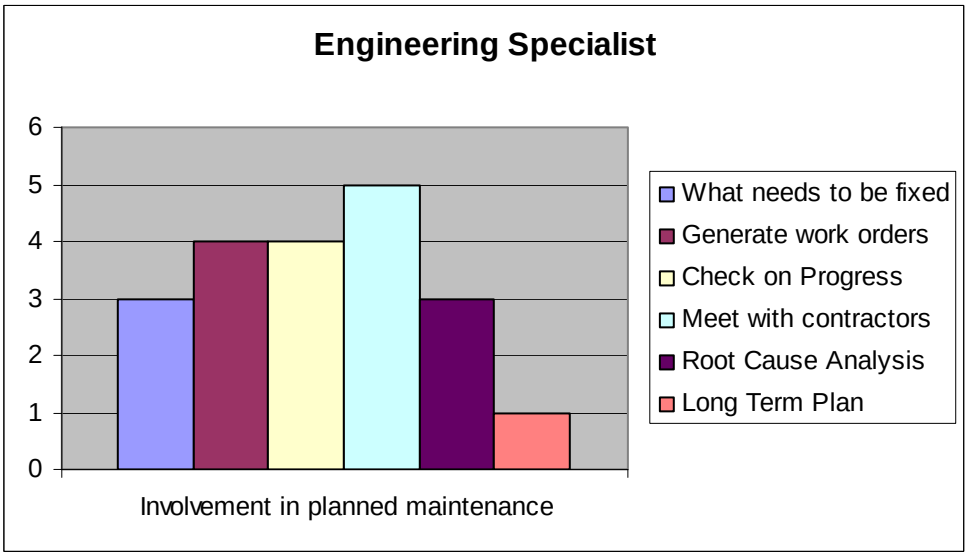
8) What kind of improvements would you like to see in the current method for predicting and dealing with failures?

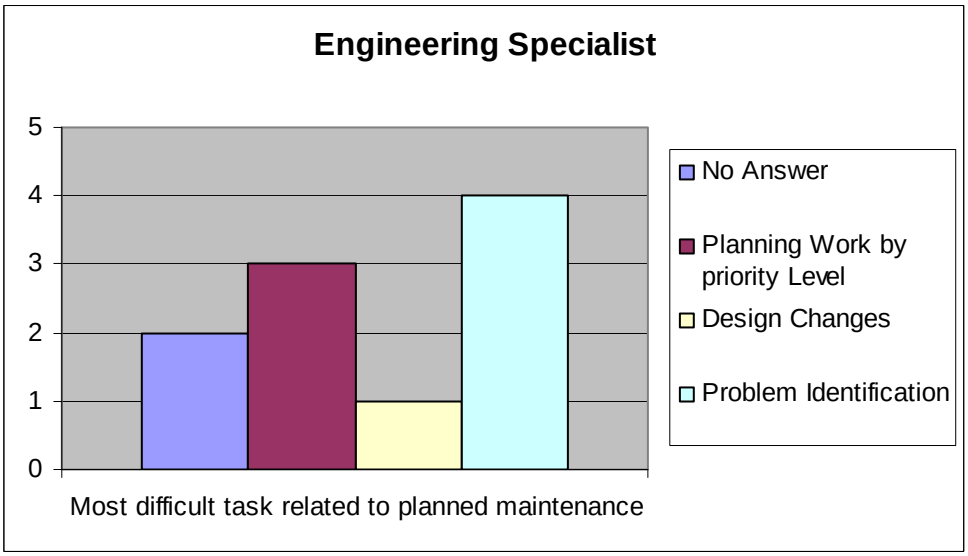
9) How long do typical and serious unplanned maintenances last? How often does unplanned maintenance happen?

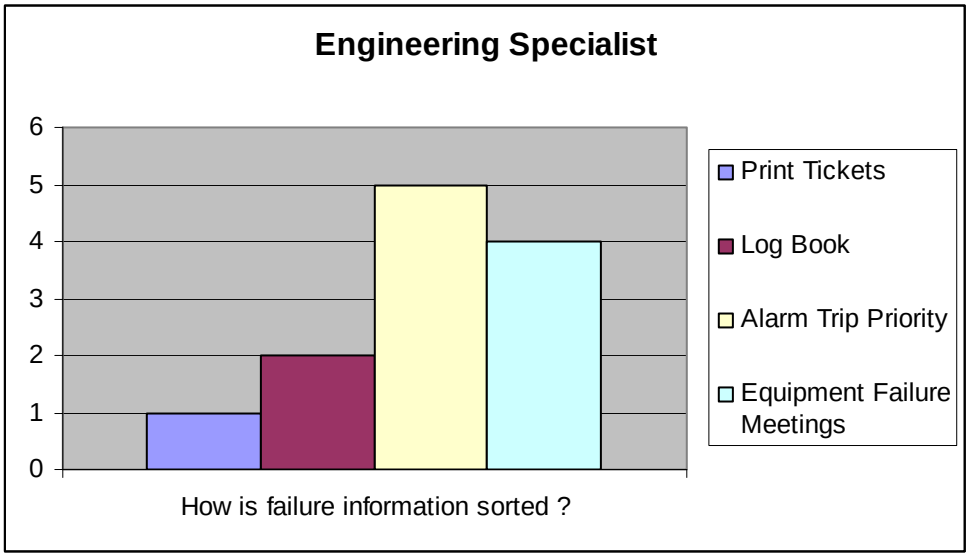
APPENDIX IV : ANALYSIS CHARTS

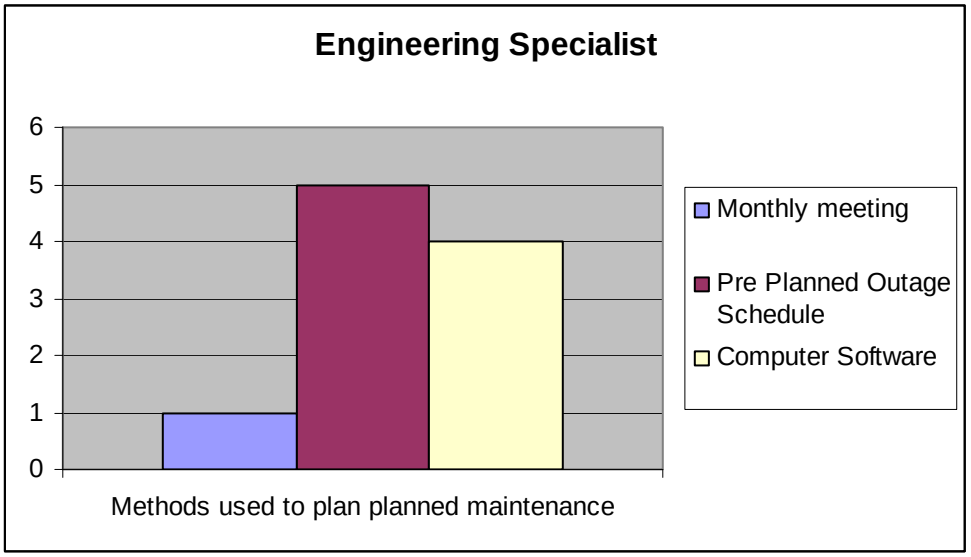
Engineering Specialist:

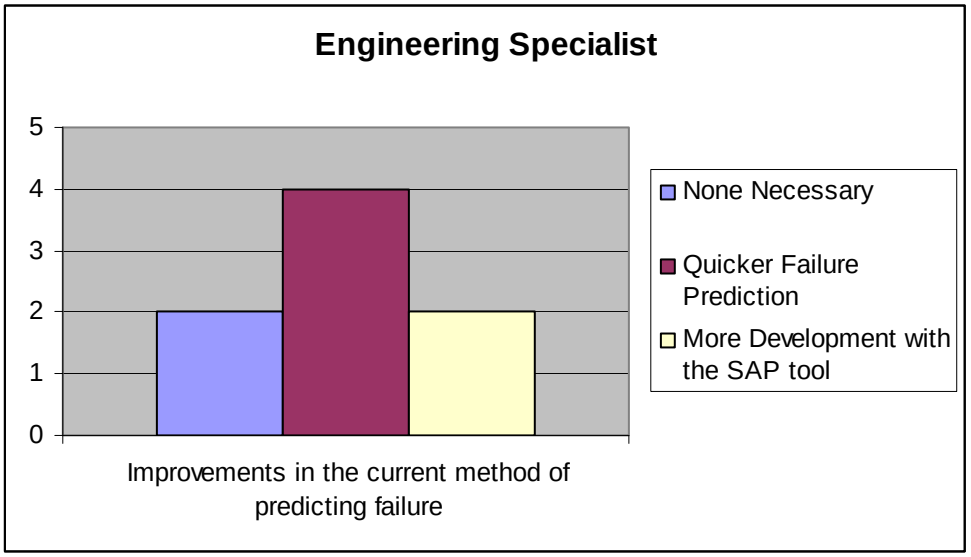

Engineering Specialist
6
5
4
3
2
1
0
Attend Meetings
Monitor Operation
Planning Maintenance
Log review
Performance Review
Generate work orders
Prioritize Alerts
Duties on a typical day on the job

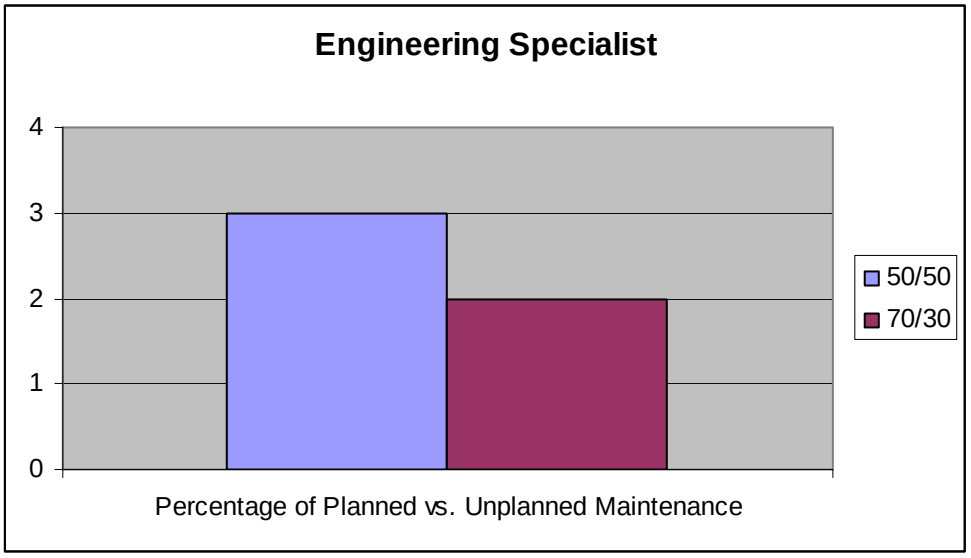

Engineering Specialist
6
5
4
3
2
1
0
What needs to be fixed
Generate work orders
Check on Progress
Meet with contractors
Root Cause Analysis
Long Term Plan
Involvement in planned maintenance

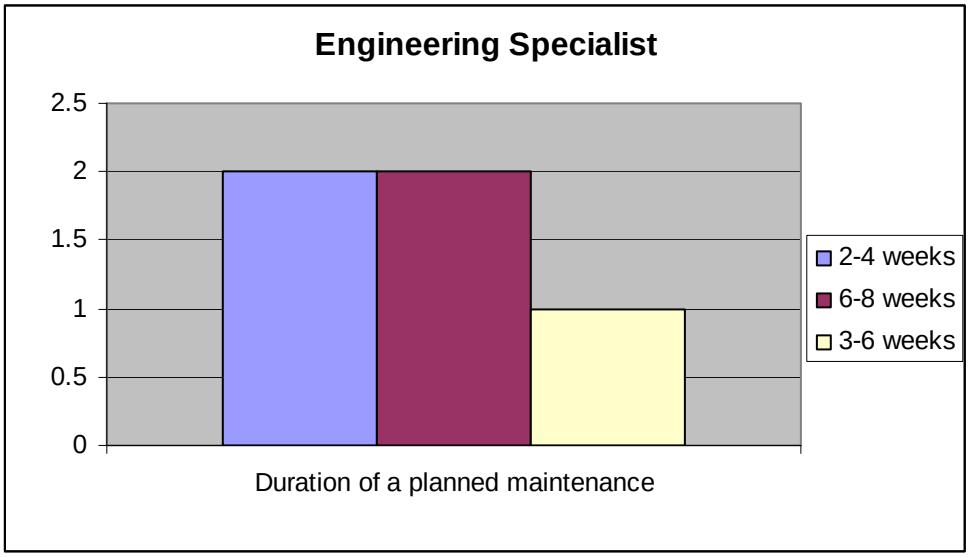

Engineering Specialist
5
4
3
2
1
0
No Answer
Planning Work by priority Level
Design Changes
Problem Identification
Most difficult task related to planned maintenance

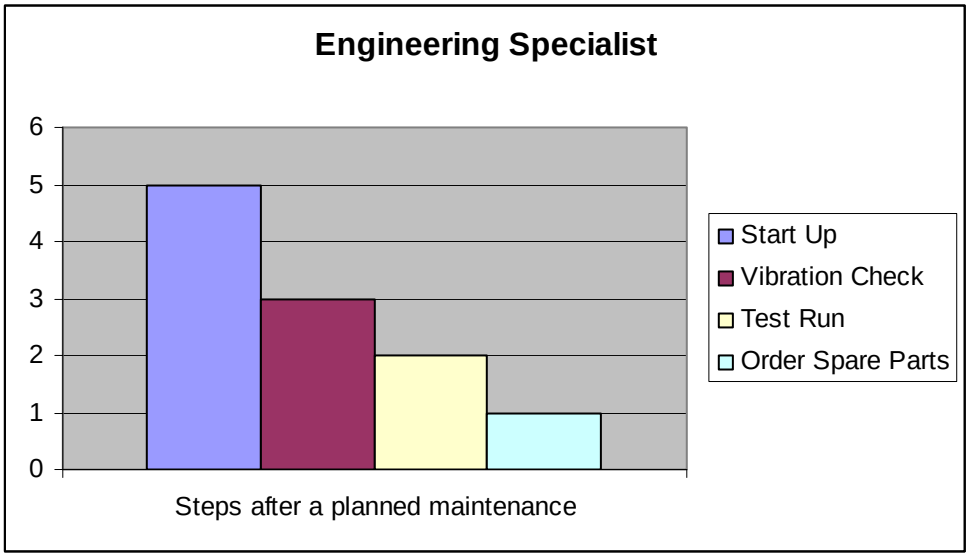

Engineering Specialist
6
5
4
3
2
1
0
Print Tickets
Log Book
Alarm Trip Priority
Equipment Failure Meetings
How is failure information sorted ?


Engineering Specialist
6
5
4
3
2
1
0
Monthly meeting
Pre Planned Outage Schedule
Computer Software
Methods used to plan planned maintenance

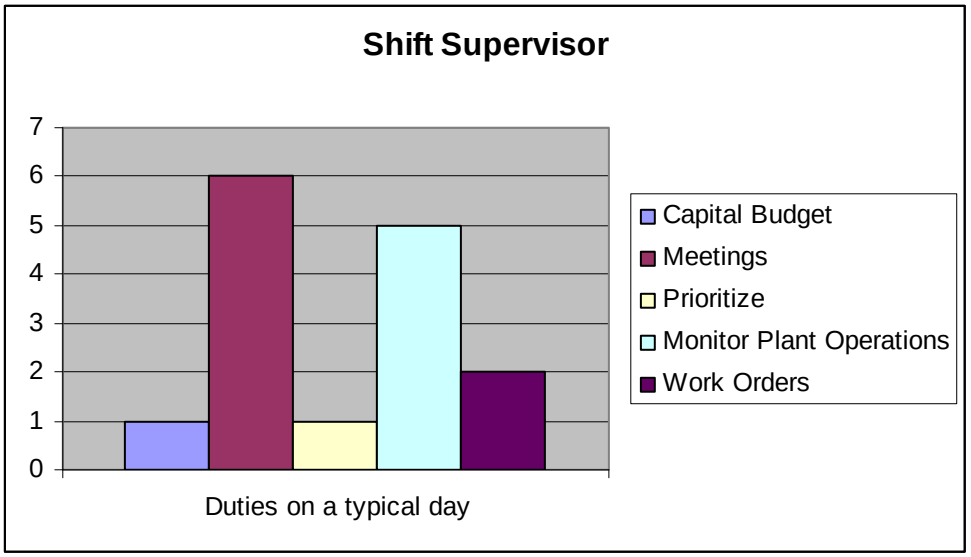

Engineering Specialist
5
4
3
2
1
0
None Necessary
Quicker Failure Prediction
More Development with the SAP tool
Improvements in the current method of predicting failure

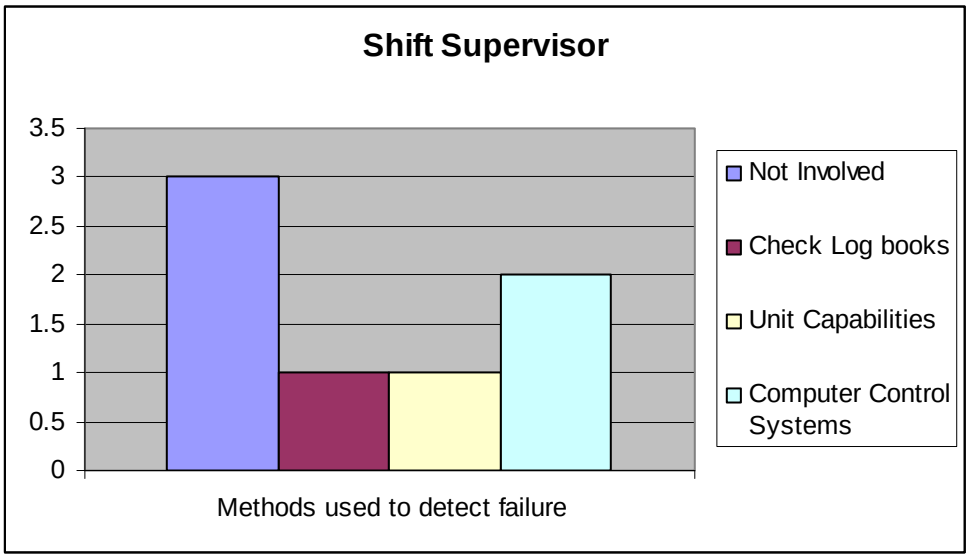

Engineering Specialist
4
3
2
1
0
50/50
70/30
Percentage of Planned vs. Unplanned Maintenance

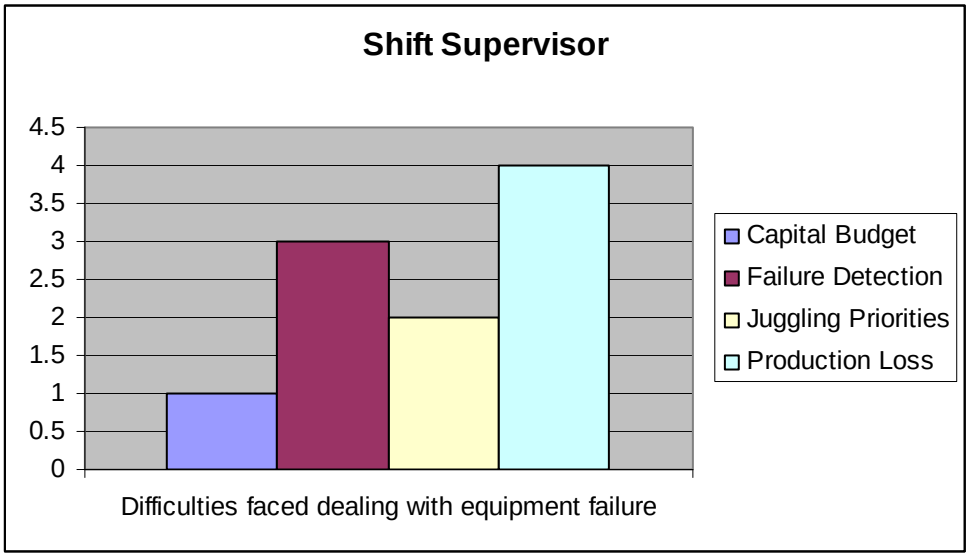

Engineering Specialist
2.5
2
1.5
1
0.5
0
2-4 weeks
6-8 weeks
3-6 weeks
Duration of a planned maintenance

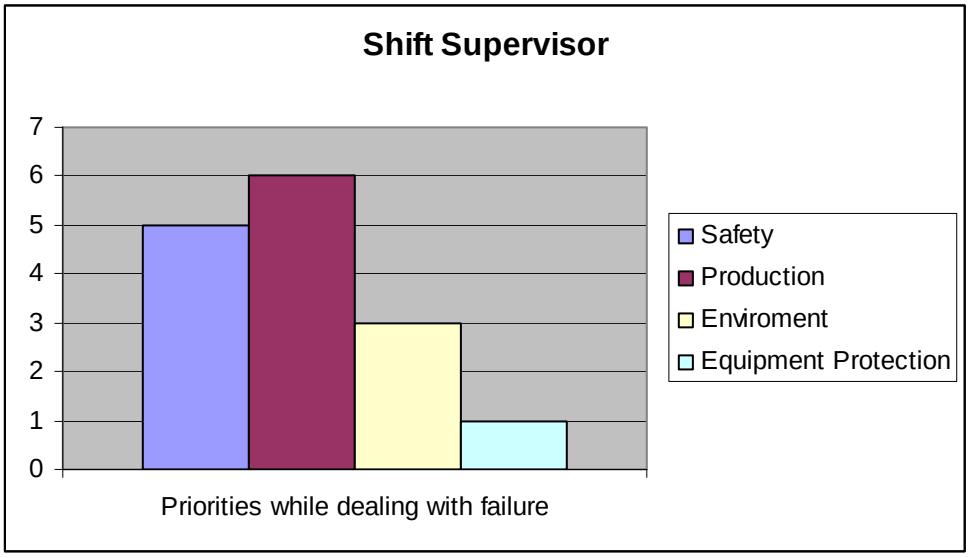

Engineering Specialist
6
5
4
3
2
1
0
Start Up
Vibration Check
Test Run
Order Spare Parts
Steps after a planned maintenance

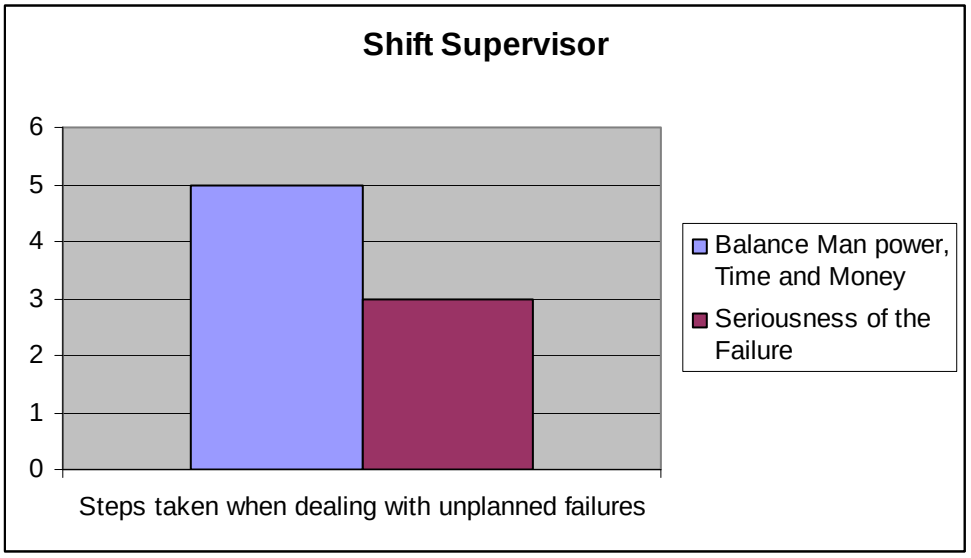
Shift Supervisor:

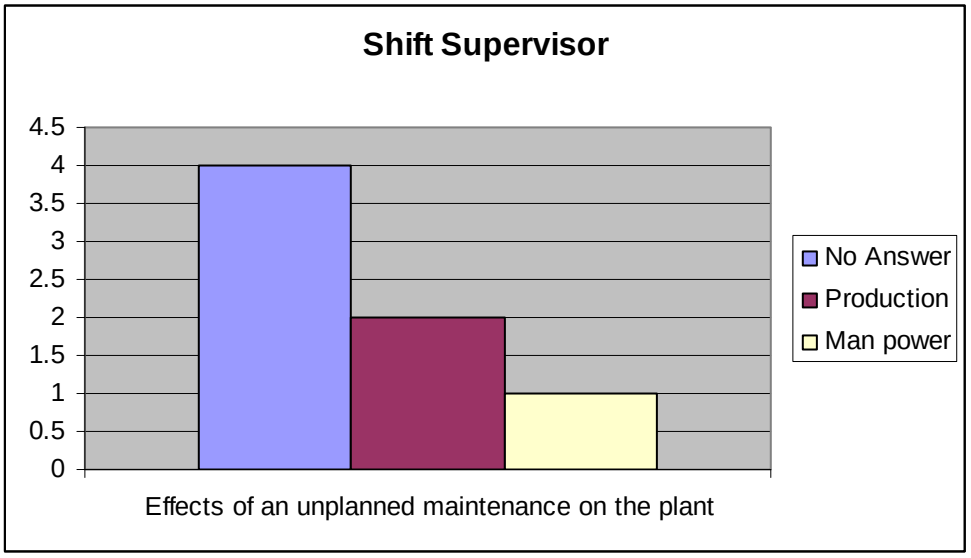


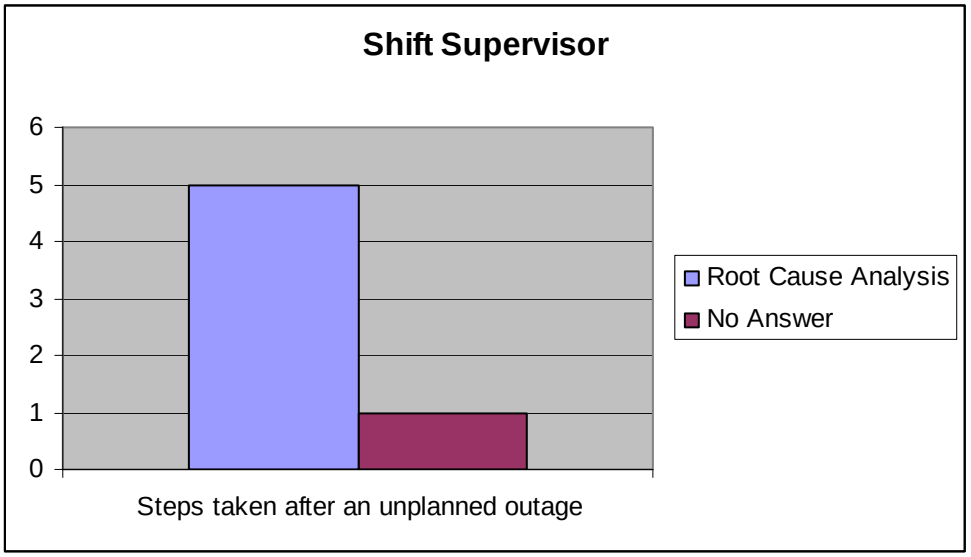


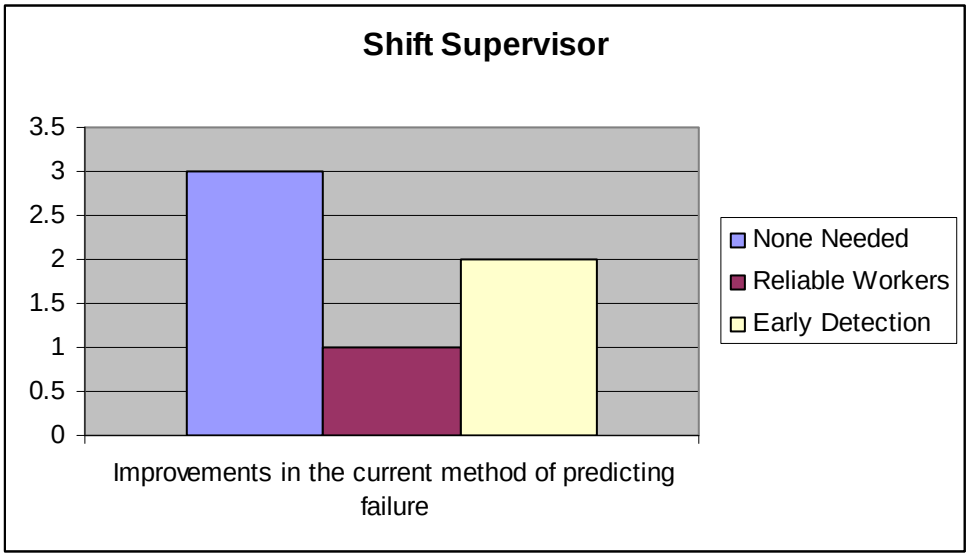

Shift Supervisor
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Capital Budget
Failure Detection
Juggling Priorities
Production Loss
Difficulties faced dealing with equipment failure

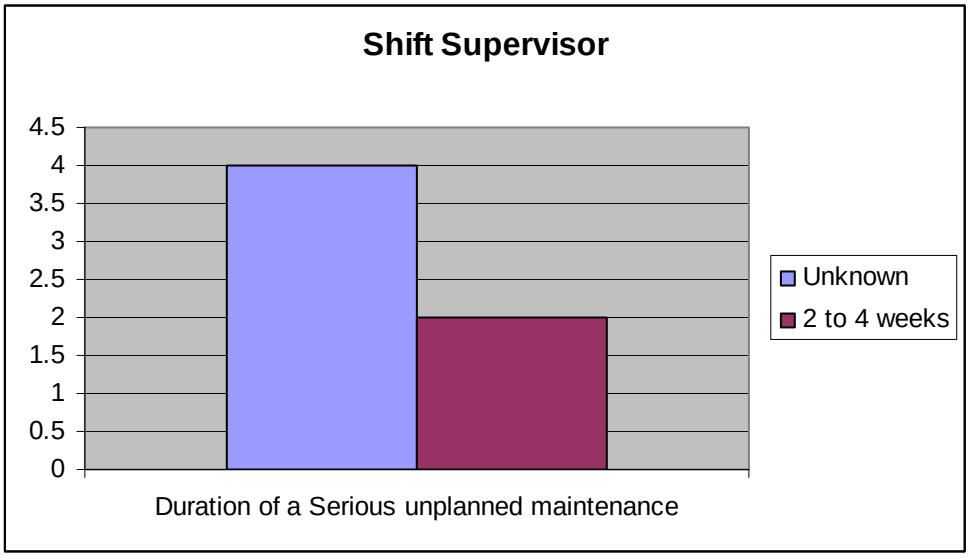

Shift Supervisor
7
6
5
4
3
2
1
0
Safety
Production
Enviroment
Equipment Protection
Priorities while dealing with failure


Shift Supervisor
6
5
4
3
2
1
0
Balance Man power, Time and Money
Seriousness of the Failure
Steps taken when dealing with unplanned failures


Shift Supervisor
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
No Answer
Production
Man power
Effects of an unplanned maintenance on the plant


Shift Supervisor
6
5
4
3
2
1
0
Root Cause Analysis
No Answer
Steps taken after an unplanned outage


Shift Supervisor
3.5
3
2.5
2
1.5
1
0.5
0
None Needed
Reliable Workers
Early Detection
Improvements in the current method of predicting failure


Shift Supervisor
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Unknown
2 to 4 weeks
Duration of a Serious unplanned maintenance

APPENDIX V

CONTENTS of IPRO 303 Fall 2007 CD-ROM

I. IPRO Office Deliverables

\Deliverables\Code of Ethics

\Deliverables\Final Report

\Deliverables\Meeting Minutes

\Deliverables\Midterm Presentation

\Deliverables\Midterm Report

\Deliverables\Project Plan

\Deliverables\Final Presentation

\Deliverables\Abstract

II. Pictures from plant tours

\Pictures

III. Project Organization and Timeline

\Team Organizational Charts\Tasks and Timeline - MS PROJECT

\Team Organizational Charts\Team Structure - MS VISIO